

Claims after amendments filed with response to 1/30/02 Office Action



## CLAIMS

22. (Amended) A wellbore fluid of the water-in-oil emulsion type useful for electrical well-logging comprising a discontinuous aqueous or brine phase, solids, and having a non-aqueous continuous liquid phase that comprises a polar organic liquid POL which exhibits a dielectric constant of at least about 5.0 and a Hildebrand Solubility Parameter of at least about 17 ( $J \text{ cm}^{-3}\right)^{1/2}$  so that the liquid phase exhibits an electrical conductivity of not less than  $10 \mu\text{S m}^{-1}$  at 1 kHz.

23. A wellbore fluid as in claim 22, wherein the non-aqueous liquid phase further comprises a water immiscible organic liquid OL.

24. A wellbore fluid as in claim 23, wherein the non-aqueous liquid phase is comprised of 1 to 99% by volume of POL + 99 to 1% by volume OL, and more preferably of 5 to 95% by volume of POL and 95 to 5% by volume of OL.

25. (Amended) A wellbore fluid of the water-in-oil emulsion type comprising a discontinuous aqueous or brine phase, solids, a water immiscible organic liquid OL, and having a non-aqueous continuous liquid phase that comprises a polar organic liquid POL which exhibits a dielectric constant of at least about 5.0 and a Hildebrand Solubility Parameter of at least about 17 ( $J \text{ cm}^{-3}\right)^{1/2}$  so that the liquid phase exhibits an electrical conductivity of not less than  $10 \mu\text{S m}^{-1}$  at 1 kHz, wherein the non-aqueous liquid phase further comprises a dissolved component (DC) selected from: water; inorganic salts wherein the anion(s) is (are) a conjugate base of an acid whose dissociation constant ( $pK_a$ ) in water at 298 °K is less than about 1.0, and the cation is ammonium ion or a metal ion which has an ionic radius of less than about 2/3 of the ionic radius of the pre-selected anion; quaternary ammonium salts or hydroxides; N-alkyl pyridinium salts or hydroxides; and organic bases exhibiting a  $pK_a$  in water at 298 °K of more than 10.0, and their salts.

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26. A wellbore fluid as in claim 25, wherein the non-aqueous liquid phase comprises of about 0.1 % to about 50% by volume of the dissolved component DC.

27. A wellbore fluid as in claim 26, wherein the non-aqueous liquid phase comprises 1 to 98.5% by volume POL , 1 to 98.5% by volume OL and 0.5 to 50% by volume DC.

28. (Amended) A wellbore fluid as in claim 25 wherein the polar organic liquid POL is one or more selected from the group consisting of alcohols, phenols, glycols, polyalkylene glycols, mono alkyl or mono aryl ethers of glycols, mono alkyl or mono aryl ethers of polyalkylene glycols, monoalkanoate esters of glycols, monoalkanoate esters of polyalkylene glycols, ketones possessing also hydroxyl group(s), diketones.

29. (Amended) A wellbore fluid as in claim 25, wherein the polar organic liquid POL component is selected from the group consisting of:

- aliphatic and alicyclic alcohols of carbon numbers C<sub>5</sub>-C<sub>10</sub>;
- phenols;
- glycols;
- polyalkylene glycols;
- mono-alkyl or mono-aryl ethers of glycols or polyalkylene glycols;
- diacetone alcohol (4-hydroxy-4-methyl-1,2-pentanone); acetylacetone; acetonylacetone.

30. (Amended) A wellbore fluid as in claim 25, wherein the polar organic liquid POL is an aprotic solvent.

31. (Amended) A wellbore fluid as in claim 25 wherein the inorganic salt comprises anions which are the conjugate base of an acid selected from the group consisting of hydrochloric acid; hydrobromic acid; hydroiodic acid; thiocyanic acid; perchloric acid; nitric acid; permanganic acid; sulphuric acid; alkane sulphonic acids; arene

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sulphonic acids; alkylaryl sulphonic acid; alkane and arene sulphonic acids substituted with electron-withdrawing groups.

32. A wellbore fluid as in Claim 25 wherein the quaternary ammonium salts or hydroxides are the chlorides, bromides, iodides, methosulphates, ethosulphates or hydroxides of quaternary ammonium cations having alkyl and/or aryl and/or alkylaryl groups such that the total number of carbon atoms in all the groups combined with the nitrogen atom is in the range 8 to 60, and more preferably in the range 12 to 40.

33. (Amended) A wellbore fluid as in Claim 25 wherein the organic base(s) exhibiting a  $pK_a$  in water of more than 10.0 is selected from the group consisting of mono-, di-, and tri-alkylamines wherein the alkyl groups contain from 2 to 18 carbon atoms; alkylpiperidines; alkylpyrrolidines; N-alkylated ethyleneamines; and their salts.

34. (Amended) A wellbore fluid of the water-in-oil emulsion type comprising a discontinuous aqueous or brine phase, solids having a non-aqueous continuous liquid phase that comprises that comprises from about 99.5% to about 50% by volume of a water immiscible organic liquid OL and about 0.5% to about 50% by volume of a dissolved component (DC) selected from: water; inorganic salts wherein the anion(s) is (are) a conjugate base of an acid whose dissociation constant ( $pK_a$ ) in water at 298 °K is less than about 1.0, and the cation is ammonium ion or a metal ion which has an ionic radius of less than about 2/3 of the ionic radius of the pre-selected anion; quaternary ammonium salts or hydroxides; N-alkyl pyridinium salts or hydroxides; and organic bases exhibiting a  $pK_a$  in water at 298 °K of more than 10.0, and their salts, said continuous liquid phase exhibiting an electrical conductivity of not less than  $10 \mu\text{S m}^{-1}$  at 1 kHz.

35. (Amended) A wellbore fluid as in claim 25, wherein the water immiscible organic liquid OL is one, or a mixture of two or more, liquid(s) selected from the group

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consisting of crude oil; hydrocarbon fractions refined from crude oil; synthetic hydrocarbons; and natural oils.

36. (Amended) A wellbore fluid as in claim 34, wherein the water immiscible organic liquid OL is one, or a mixture of two or more, liquid(s) selected from the group consisting of crude oil; hydrocarbon fractions refined from crude oil; synthetic hydrocarbons; synthetic liquids, alkyl alkanoate esters, acetals; and natural oils.

37. (Amended) A wellbore fluid as in claim 25 wherein a discontinuous liquid phase is added together with one or more emulsifier to form a water-in-organic-liquid emulsion wherein the discontinuous phase is present at up to 70% by volume of the emulsion.

38. (Amended) A wellbore fluid as in claim 25 wherein it further comprises a dispersion in the wellbore fluid of finely divided particles of an electrically conducting solid insoluble in the organic liquid or water.

39. (Amended) A wellbore fluid as in Claim 38 wherein the finely divided electrically conducting solid is selected from the group consisting of metals; carbon preferably in the form of graphite or carbon fibre; metal coated carbon fibre or graphite; and conductive polymers.

40. A wellbore fluid as in Claim 39 wherein the finely divided conducting solid is in the form of high aspect ratio fibres, flakes or platelets.

41. (Amended) A wellbore fluid as in claim 25 further comprising functional wellbore fluid components.

42. (Amended) A method of drilling or completing a well wherein the used wellbore fluid is of the water-in-oil emulsion type useful for electrical well-logging comprising a discontinuous aqueous or brine phase, solids ,and having a non-aqueous continuous liquid phase that comprises a polar organic liquid POL which exhibits a dielectric constant of at least about 5.0 and a Hildebrand Solubility Parameter of at least about

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17 (J cm<sup>-3</sup>)<sup>1/2</sup> so that the liquid phase exhibits an electrical conductivity of not less than 10  $\mu$ S m<sup>-1</sup> at 1 kHz.

43. (Amended) A method of providing enhanced information from electrical logging tools, measurement while drilling, logging while drilling, and geosteering wherein the efficiency is enhanced by the improved electrical conductivity of a of the water-in-oil emulsion type comprising a discontinuous aqueous or brine phase, solids and having a non-aqueous continuous liquid phase that comprises a polar organic liquid POL which exhibits a dielectric constant of at least about 5.0 and a Hildebrand Solubility Parameter of at least about 17 (J cm<sup>-3</sup>)<sup>1/2</sup> so that the liquid phase exhibits an electrical conductivity of not less than 10  $\mu$ S m<sup>-1</sup> at 1 kHz.

44. (NEW) A wellbore fluid as in claim 22 wherein the solids are clays or weighting materials.

45. (NEW) A wellbore fluid as in claim 29, wherein the aliphatic and alicyclic alcohols are selected from the group consisting of *n*-pentanol, cyclohexanol, *n*-octanol, 2-ethylhexanol, and *n*-decanol; the phenols are selected from the group consisting of ortho, meta, or para cresol; the polyalkylene glycols are selected from the group consisting of polypropylene glycols of molecular weight above about 1000, polybutylene glycols, polytetrahydrofuran, polyalkylene glycols or copolymers of ethylene oxide and/or propylene oxide and/or butylene oxide initiated by any hydroxylic or amino-functional moiety wherein the polyalkylene glycol or copolymer is further characterised by exhibiting a cloud point (at 1% concentration in water) of less than about 10 °C; the mono-alkyl or mono-aryl ethers of alcohols or polyalkylene glycols are selected from the group consisting of ethylene glycol monobutyl ether, diethylene glycol monobutyl ether, dipropylene glycol monomethyl ether, tripropylene glycol monomethyl ether, propylene glycol monobutyl ether, dipropylene glycol monobutyl ether, tripropylene glycol monobutyl ether, propylene glycol phenyl ether, dipropylene glycol phenyl ether.

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46. (NEW) A wellbore fluid as in Claim 25, wherein the alkane sulphonic acids are selected from the group consisting of sulphonic acid and ethane sulphonic acid; the arene sulphonic acids are selected from the group consisting of benzene sulphonic acid and naphthalene sulphonic acid; and the alkane and arene sulphonic acids substituted with electron-withdrawing groups are selected from the group consisting of trifluoromethane sulphonic acid and 2,4-dinitrobenzene sulphonic acid, picric acid, and trichloracetic acid.

47. (NEW) A wellbore fluid as in Claim 34, wherein the solids are clays or weighting materials.

48. (NEW) A wellbore fluid as in Claim 35 wherein the synthetic hydrocarbons are selected from the group consisting of *n*-paraffins, alphaolefins, internal olefins, and polyalphaolefins; synthetic liquids such as dialkyl ethers, alkyl alkanoate esters, acetals; and the natural oils are selected from the group consisting of triglycerides, rape-seed oil, and sunflower oil.

49. (NEW) A wellbore fluid as in Claim 36 wherein the synthetic hydrocarbons are selected from the group consisting of *n*-paraffins, alphaolefins, internal olefins, and polyalphaolefins; synthetic liquids such as dialkyl ethers, alkyl alkanoate esters, acetals; and the natural oils are selected from the group consisting of triglycerides, rape-seed oil, and sunflower oil.

50. (NEW) A wellbore fluid as in Claim 37, wherein the discontinuous liquid phase is water or a brine.

51. (NEW) A wellbore fluid as in Claim 39, wherein the conductive polymers are polyaniline, polypyrrole, and organometallic phthalocyanines.

52. (NEW) A wellbore fluid as in Claim 41, wherein the functional wellbore fluid components are selected from the group consisting of clay, organoclay, polymeric viscosifiers, filtration reducers, weighting agents, or a lubricating additive.

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53. (NEW) A wellbore fluid as in Claim 42, wherein the solids are clays or weighting materials.

53. (NEW) A wellbore fluid as in Claim 43, wherein the solids are clays or weighting materials.